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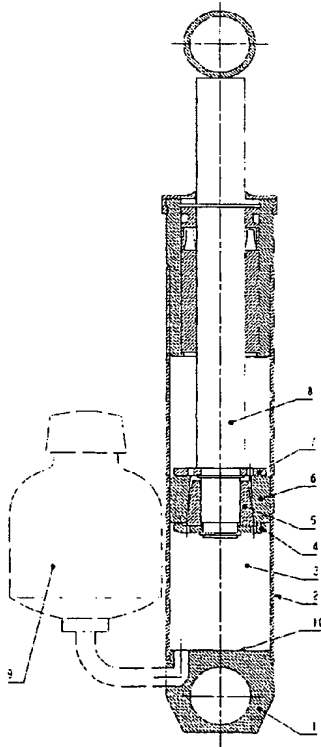
PCT

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- (71) Applicant (*for all designated States except US*): ASA-SUSPENSION AB [SE/SE]; Stållverksvägen 39, S-981 38 Kiruna (SE).
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[Continued on next page]

(54) Title: HYDRAULIC VEHICLE SHOCK ABSORBER



(57) Abstract: A hydraulic shock absorber comprises a cylindrical chamber (3), which is closed at one end and in which is axially slidably guided a piston member (5), supported by a piston rod (8) and at its peripheral surface carrying a surrounding non-slotted elastic ring element (6), the peripheral piston member surface being conically converging in a direction away from the closed chamber end and the inner surface of the ring element also conically converging in the same direction, the ring element (6) furthermore being axially reciprocally mounted on the piston member (5) between a first rigid abutment (7) at the end of said member (5) closest to the closed end (10) of the chamber (3), and a second rigid abutment (9) on the piston member (5) at a spacing from the first abutment (7) exceeding the axial length of the ring element (6). In order to increase the speed of response of the absorber the invention suggests that the two conical surfaces have mutually different conicity with core angles and diameters such selected that in an outward return movement of the piston member (5) the same is urged with its steeper conical peripheral surface against the less conical inner surface of the surrounding ring element (6) and brings the first abutment (7) into engagement with yieldable ring element (6) while - at the same time - radially expanding the same so as to leave only a small intentional clearance for letting through hydraulic fluid between the outer surface of the ring element (6) and the inner surface of the cylinder.

WO 2004/018896 A1

WO 2004/018896 A1



For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

HYDRAULIC VEHICLE SHOCK ABSORBER

The present invention refers to an improved hydraulic vehicle shock absorber intended to provide an optimum damping action only when there is a real need thereof and then to a well controlled level. In fact, a hydraulic vehicle shock absorber according to the invention comprises a cylindrical chamber which is closed at one end and in which is axially slidably guided a piston member supported by a piston rod and at its peripheral surface carrying a surrounding non-slotted elastic ring element, the peripheral piston member surface being conically converging in a directional wave from the closed chamber end and the inner surface of the ring element also conically converging in the same direction, the ring element furthermore being axially slidably mounted on the piston member between a first rigid abutment at the end of a said member closest to the closed end of the chamber and a second rigid abutment on the piston member at a spacing from the first abutment exceeding the axial length of the ring element.

Motion or shock absorber designs with co-operating conical surfaces are known in several connections. Thus DE 196 42 80 C1 shows such a design with a co-operating conical surfaces in connection with a pneumatic motion damper for e.g. a glove compartment lid. On a piston with conical outer surface slidably guided in a cylinder is carried a correspondingly conical sleeve like ceiling being slightly axially movable on the piston and on its auto-surface having a ceiling colour engaging the surrounding cylinder wall. The damping or absorbing fluid, in the present case air, therefore can not pass between the ceiling sleeve and in the cylinder wall but only through a restricted channel in the conical surfaces when the same are engaging each other during the piston rod

movement out of the cylinder. In the opposite motion
directional piston the mutual engagement of the conical
surfaces abruptly due to the interference dresses in the ring
element and a greater cross sectional area is made free to the
5 absorbing fluid. Mutually co-operating conical surface also
may be used to provide in a cylindrical chamber is suitable
herging walls against the cylinder wall and in this manner by
friction to provide a damping action on a motion, such as
described in FR A 1 077 611. In US A 2,912,069 is described
10 how an elastic insert body provided with a conical surface may
serve as a valve member in a shock absorber structure in order
to make the same more silent in operation. EP 0 198 A2
describes a piston- and ring-arrangement in a shock-absorber
design in order to provide for as few parts as possible,
15 namely two. Finally, FR A 2 493 443 shows mutually co-
operating conical surfaces which provides for the expansion of
a break means creating a friction force against a cylinder
wall.

Most of the present vehicle shock absorber structures of
20 hydraulical type usually comprise a piston member carried by a
piston rod and provided with central penetrating bores or
channels with a plurality of valve means and spring means. A
drawback of such structures is that they necessarily show a
non-essential time lag in their operation as the same time
25 as the fluid or oil passing through the piston becomes heavily
agitated which leads to the formation of foam and generation
of heat. Said generation of heat in its turn leads to changes
of the viscosity of the absorbing fluid and therefore cooling
measures often are required. In motorcycles and particularly
30 in snow mobiles there occurs an inconvenient phenomenon in the
form of so-called memory action of the shock absorbers. If for
instance the front steering skis of the snow mobiles are

mounted in spring struts provided with shock absorbers it is essential that the damping of the outward movement of the spring strut after a compression occurs distinctly but extremely fast since otherwise in a new closely following compression spring movement the shock absorber has not yet allowed the spring strut to extend completely. In a plurality of such compressions of the spring strut following closely after each other in a regularly uneven path or the like in various types of country driving, the spring strut finally may stop into a completely compressed position and thus act as being fully rigid. Since it is important that the spring absorbs most of the impact force against a obstacle, the shock absorbing or damping action usually is selected small at the compression movement, to a magnitude of about 10%, while a shock absorbing or damping action of about 90% is desired at the movement outwardly. The shock absorber according to the invention may also advantageously be used in most other vehicles than the above-stated.

Now the present invention aims that providing a sensing or active shock absorbing structure the action of which adapts itself to after the need of damping. According to the invention this is obtained substantially in that the two conical surfaces are formed with mutually different conicity with cone angles and diameters such selected that in an outward return movement of the piston/member the same is urged with its steeper conical peripheral surface against the less conical inner surface of the surrounding ring element and brings the first abutment into engagement with the yieldable ring element while - at the same time - radially expanding the same so as to leave only a small intentional clearance for letting through hydraulic fluid between the outer surface of the ring element and the inner surface of the cylinder.

Besides the activation operation of the shock absorber according to the invention thus mentioned the same also provides a much smaller agitation action on the hydraulic fluid - also by shorter periods of action - and owing to the fact that the fluid passes closest to the cylinder wall said fluid may easily be cooled in an advantageous way. Prior shock absorber designs often have had a constant absorbing or damping action due to the design but the absorber according to the invention may better be called active in its operation since its function changes after the needs. The ring element namely will expand and hence reduce the through-flow area of the hydraulic fluid due to the magnitude of the liquid pressure which occurs by the speed of the fluid, thus a sensing action. The expansion of the ring element provided for by the co-operation of the conical surfaces may provide very great forces in this element by only small axial movements between the piston member and the ring element and hence also a very fast return to the released position with fully exposed cross sectional area.

By way of example the invention will be further described below with reference to the accompanying drawing in which Figure 1 illustrates a longitudinal section through an inventive shock absorber and Figures 2a and b show sectional detail views to an enlarged scale of the ring element and the piston member in non-active and in active shock absorbing position, respectively.

In the drawing it is thus illustrated a shock absorber according to the invention comprising an extended cylinder 2 in which is slidably guided a piston 5 carried by a piston rod 8. Externally the piston 5 is surrounded by a non-slotted ring 6 and the latter is mounted longitudinally slidable between a

first end abutment 4 on the piston rod 8 at the end closest to the closed cylinder end 9 and a second abutment 7 located at an axial distance on the piston rod from the end of abutment 4 greater than the axial length of the piston 5.

- 5 Within the cylinder 2 the piston 5 restricts a chamber 3 and as known the cylinder is filled with hydraulic fluid. According to the invention the peripheral surface of the piston 5 is made conically converging in the direction from the closed cylinder end 9, while the surrounding ring 6 in a
10 similar way is internally conically converging in the same direction. The conical angle α_1 of the peripheral surface of the piston 5 is, however, greater than the conical inner surface of the ring 6 for a purpose to be further described below.
- 15 In a compression of the spring member co-operating with the shock absorber the piston 5 and the ring 6 are together with the piston rod 8 urged inwardly in the cylinder 2 thereby letting the hydraulic fluid in the chamber 3 flow both between the conical surfaces and between the outer surface of the ring
20 6 and the surrounding cylinder wall such as illustrated in Fig. 2a. The shock absorbing action aimed at in the normal case in such a compression of the shock absorber amounts in this case to about 10% and may easily be obtained by suitable dimensioning of the piston 5 and the ring 6 as well as the
25 cylinder 2.

- In a return movement of the non-illustrated spring member, such as illustrated in Fig 2b, with accompanying extraction of the piston rod 8 out of the cylinder 2, which rapidly and with a very great force since the spring compression has
30 accumulated the force of the spring movement, the abutment 4 carries the piston 5 axially with its conical surface into the

internal conical surface of the surrounding ring 6 during simultaneous radial expansion of the resilient ring 6.

However, the latter is such dimensioned in its outer diameter that it will not come into engagement with the inner surface of the surrounding cylinder 2 but leave a small clearance at this wall for the hydraulic fluid to pass through. Owing to this, the action of the shock absorber will not be fully stiff but shock absorbing or damping action will be achieved suitably amounting to about 90%.

10 This condition of the shock absorber will reside only under a very short moment when the return force of the spring means is at maximum but in the next moment the two co-operating conical surfaces of the piston 5 and ring 6 will cause that the latter leaves its expanded position under axial movement relative
15 piston 5 and a rapidly increasing area will again be made free for the passage of the hydraulic fluid passed the piston 5.

According to the invention the surrounding ring 6 is resilient and even if the ring 6 might be made of the same or a similar material as the piston 5 and thus has substantially the same
20 modulus of elasticity as the latter, it is advantageous for the distinct operation of the shock absorber that the ring material has much lower modulus of elasticity, probably of one order of magnitude less than the piston material. By this an extremely fast operation of the damping and valve function of
25 the piston and ring unit will be assured. As piston material steel might primarily be selected but also brass and hard plastics. The ring 6 suitably is made of plastic. Practical tests have disclosed that it is suitable that the conical angle α_1 of the outer surface of the piston 5 is of the
30 magnitude of about 8° while the conical angle α_2 of the internal surface of the ring 6 amounts about 5° .

A preferred embodiment of the invention also comprises an axial adjustability in the co-operation between the two conical surfaces of the piston 5 and ring 6. Advantageously, this may be carried out from the exterior of the shock absorber, for instance by connecting the piston with a piston rod 8 and guiding the ring 6 axially and non-rotatably within the cylinder. Through said piston rod or alternatively by means of an adjustment member mounted therein axial adjustments of the piston 5 relative the ring 6 are made possible. Thereby the conical surface of the piston 5 might be axially adjusted and more or less exposed to the conical surface of the expanding ring 6.

In the above-stated the shock absorber according to the invention has being stated as being a separate unit for co-operation in a known manner with a leaf spring, torsion spring or helical spring in a vehicle wheel suspension or the like. However, it is also possible to integrate the shock absorber with the spring means by connecting the shock absorber chamber 3 with a gas chamber 10 as indicated with dotted lines in Fig. 1 of drawing.

Finally it is also to be emphasized that even if the invention in the above-stated primarily has been described as applied to snow mobiles and motorcycles, practical tests have shown that the inventive structure also advantageously may be applied to cars such as in rear axle suspensions.

Claims

1. A hydraulic shock absorber comprising a cylindrical chamber (3), which is closed at one end and in which is axially slidably guided a piston member (5), supported by a piston rod (8) and at its peripheral surface carrying a surrounding non-slotted elastic ring element (6), the peripheral piston member surface being conically converging in a direction away from the closed chamber end and the inner surface of the ring element also conically converging in the same direction, the ring element (6) furthermore being axially reciprocally mounted on the piston member (5) between a first rigid abutment (4) at the end of said member (5) closest to the closed and (10) of the chamber (3), and a second rigid abutment (7) on the piston member (5) at a spacing from the first abutment (4) exceeding the axial length of the ring element (6), **characterized in that** the two conical surfaces have mutually different conicity with core angles and diameters such selected that in an outward return movement of the piston member (5) the same is urged with its steeper conical peripheral surface against the less conical inner surface of the surrounding ring element (6) and brings the first abutment (4) into engagement with the yieldable ring element (6) while - at the same time - radially expanding the same so as to leave only a small intentional clearance for letting through hydraulic fluid between the outer surface of the ring element (6) and the inner surface of the cylinder.
2. A shock absorber according to claim 1, **characterized in that** the external surface of the piston member (5) has a conical angle of about 8° while the internal surface of the ring element (6) has a conical angle of about 5°.

3. A shock absorber according to claim 1 or 2, **characterized in that** the modulus of elasticity of the material of the piston member (5) is greater than that of the material of the ring element (6).
- 5 4. A shock absorber according to any of claims 1-3, **characterized in that** piston member (5) is made of metal, preferably steel or brass, and plastic, while the ring element (6) is made of plastic.

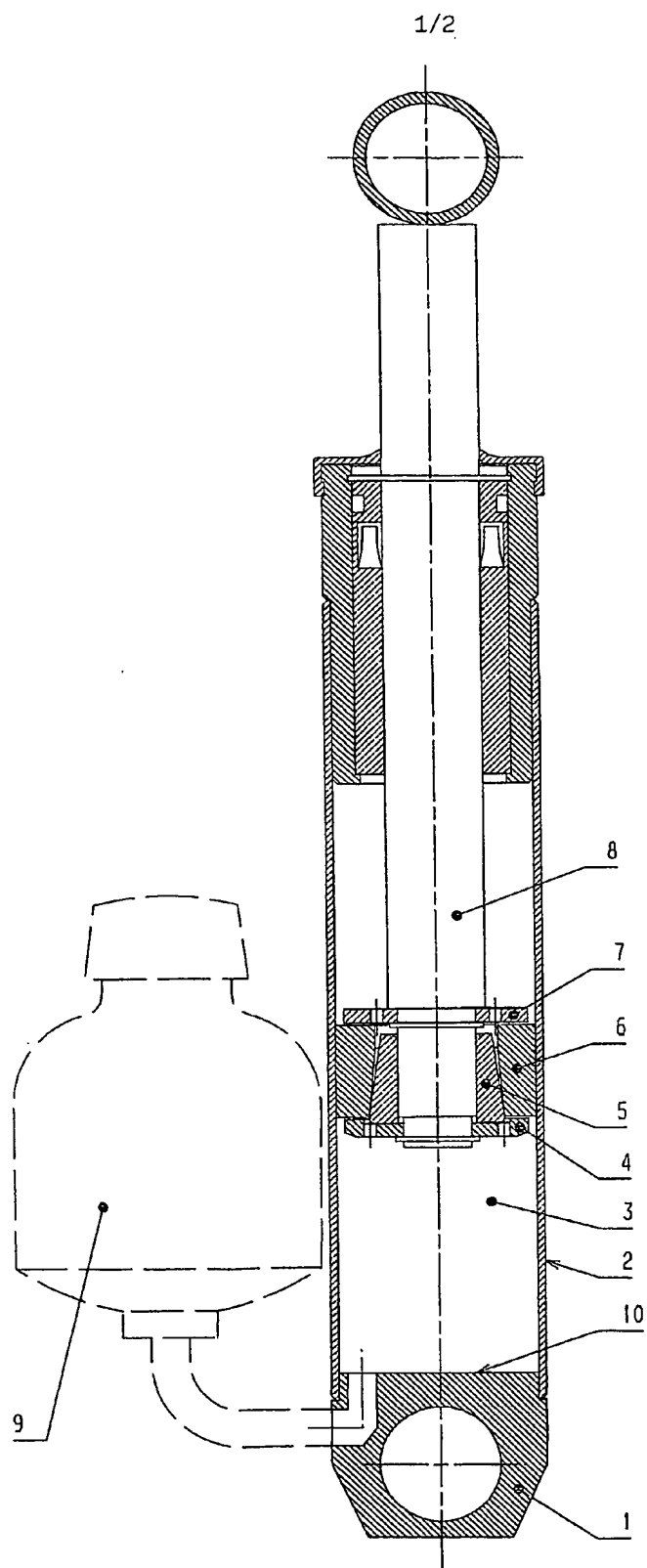


Fig. 1

2/2

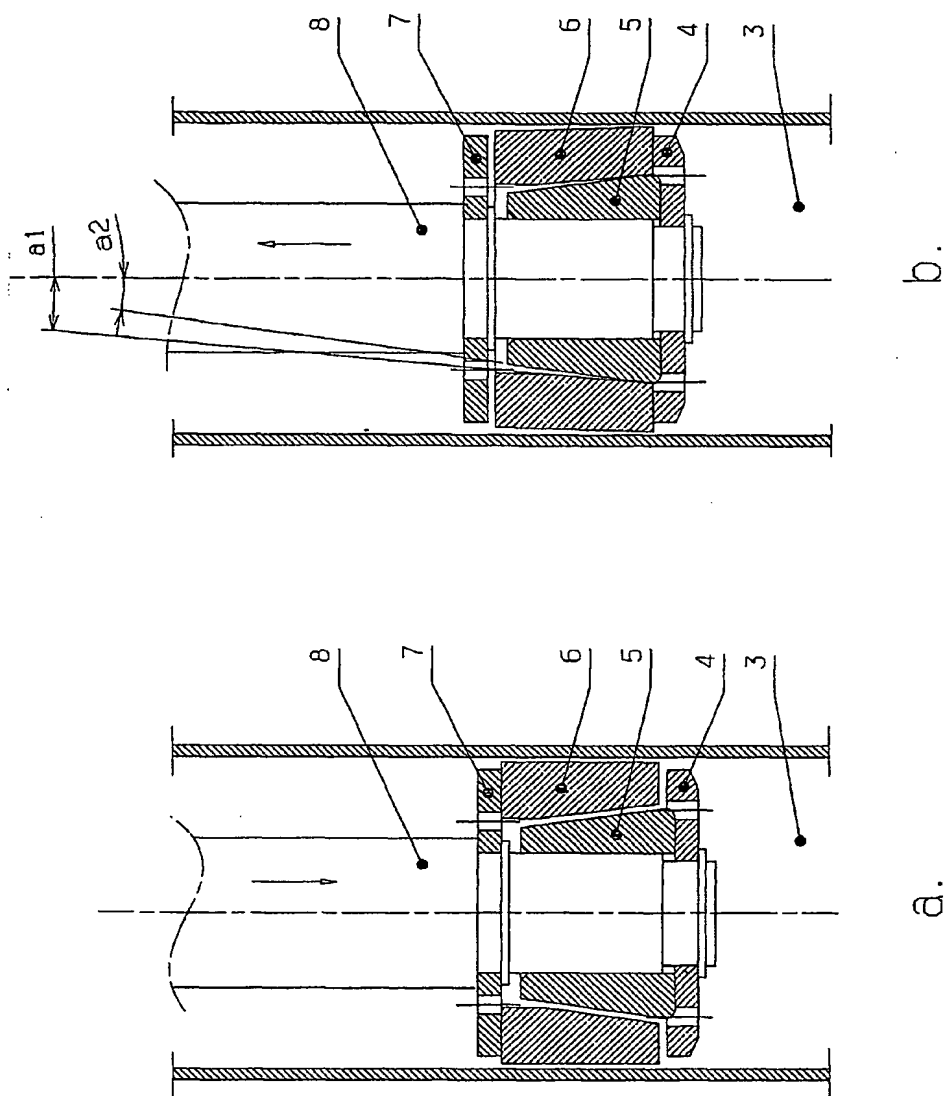


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 02/01382

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F16F 9/516

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F16F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	EP 0195150 A1 (GRUMMAN AEROSPACE CORPORATION), 24 Sept 1986 (24.09.86) --	
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A	FR 1101872 A (GIRONA), 11 October 1955 (11.10.55) --	

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

27 February 2003

Date of mailing of the international search report

27 -02- 2003

Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 02/01382

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0292881 A1 (PATON, H. NEIL), 30 November 1988 (30.11.88) --	
A	FR 1077611 A (LE GRAND), 10 November 1954 (10.11.54) --	
A	FR 2493443 A1 (BOSCH-SIEMENS HAUSGERÄTE GMBH), 7 May 1982 (07.05.82) --	
A	LU 33116 A (PAULSEN), 20 November 1954 (20.11.54) -- -----	

INTERNATIONAL SEARCH REPORT

Information on patent family members

30/12/02

International application No.

PCT/SE 02/01382

Patent document cited in search report			Publication date	Patent family member(s)		Publication date
US	2002070085	A	13/06/02	DE	10051971 C	28/03/02
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				IT	8124741 D	00/00/00
LU	33116	A	20/11/54	NONE		

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY
(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

REC'D 24 JUN 2004

WIPO

PCT

Applicant's or agent's file reference 71593/ÅD	FOR FURTHER ACTION See Form PCT/IPEA/416	
International application No. PCT/SE2002/001382	International filing date (day/month/year) 12.07.2002	Priority date (day/month/year) --
International Patent Classification (IPC) or national classification and IPC F16F 9/516		EPO - DG 1 23.07.2004
Applicant ASA-SUSPENSION AB et al		

(36)

- This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
- This REPORT consists of a total of 4 sheets, including this cover sheet.
- This report is also accompanied by ANNEXES, comprising:
 - ☐ (sent to the applicant and to the International Bureau) a total of _____ sheets, as follows:
 - ☐ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
 - ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
 - ☐ (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) _____, containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

- | | | |
|-------------------------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <input checked="" type="checkbox"/> | Box No. I | Basis of the report |
| <input type="checkbox"/> | Box No. II | Priority |
| <input type="checkbox"/> | Box No. III | Non-establishment of opinion with regard to novelty, inventive step and industrial applicability |
| <input type="checkbox"/> | Box No. IV | Lack of unity of invention |
| <input checked="" type="checkbox"/> | Box No. V | Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement |
| <input type="checkbox"/> | Box No. VI | Certain documents cited |
| <input type="checkbox"/> | Box No. VII | Certain defects in the international application |
| <input type="checkbox"/> | Box No. VIII | Certain observations on the international application |

Date of submission of the demand 26.01.2004	Date of completion of this report 21.05.2004
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. +46 8 667 72 88	Authorized officer Annette Riedel / JA A Telephone No. +46 8 782 25 00

Form PCT/IPEA/409 (cover sheet) (January 2004)

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/SE2002/001382

Box No. I Basis of the report

1. With regard to the language, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

- ☒ This report is based on a translation from the original language into the following language English, which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
- ☒ publication of the international application (under Rule 12.4)
- ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the elements of the international application, this report is based on (replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report):

- ☒ the international application as originally filed/furnished
- ☐ the description:
- pages _____ as originally filed/furnished
- pages* _____ received by this Authority on _____
- pages* _____ received by this Authority on _____
- ☐ the claims:
- pages _____ as originally filed/furnished
- pages* _____ as amended (together with any statement) under Article 19
- pages* _____ received by this Authority on _____
- pages* _____ received by this Authority on _____
- ☐ the drawings:
- pages _____ as originally filed/furnished
- pages* _____ received by this Authority on _____
- pages* _____ received by this Authority on _____
- ☐ a sequence listing and/or any related table(s) – see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (specify): _____
- ☐ any table(s) related to the sequence listing (specify): _____

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheets/figs _____
- ☐ the sequence listing (specify): _____
- ☐ any table(s) related to the sequence listing (specify): _____

* If item 4 applies, some or all of those sheets may be marked "superseded."

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/SE2002/001382

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. Statement**

Novelty (N)	Claims	<u>1-4</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-4</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-4</u>	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

The invention relates to a hydraulic shock absorber with an axially slidable piston member in a cylindrical chamber. At its peripheral surface the piston member carries a surrounding slotted elastic ring element. In order to increase the speed of response of the absorber the invention suggests that mating conical surfaces on the piston and ring, respectively, have mutually different conicity with core angles and diameters such selected that in an outward return movement of the piston member the same is urged with its steeper conical peripheral surface against the less conical inner surface of the surrounding ring element and brings a first abutment into engagement with the yieldable ring element while - at the same time - radially expanding the same so as to leave only a small intentional, clearance for letting through hydraulic fluid between the outer surface of the ring element and the inner surface of the cylinder.

Documents cited in the International Search Report:

D1: US2002070085 A
D2: EP0195150 A1
D3: DE19642806 C1
D4: FR1101872 A
D5: EP0292881 A1
D6: FR1077611 A
D7: FR2493443 A1
D8: LU33116 A

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INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/SE2002/001382

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.

Continuation of: V.

The cited documents represent the general state of the art, and the invention defined in claims 1-4 is not disclosed by any of these documents. The cited prior art does not give any indication that would lead a person skilled in the art to the claimed shock absorber. Hence, the invention defined in claims 1-4 is novel, non-obvious and is considered to involve an inventive step. The industrial applicability is evident.